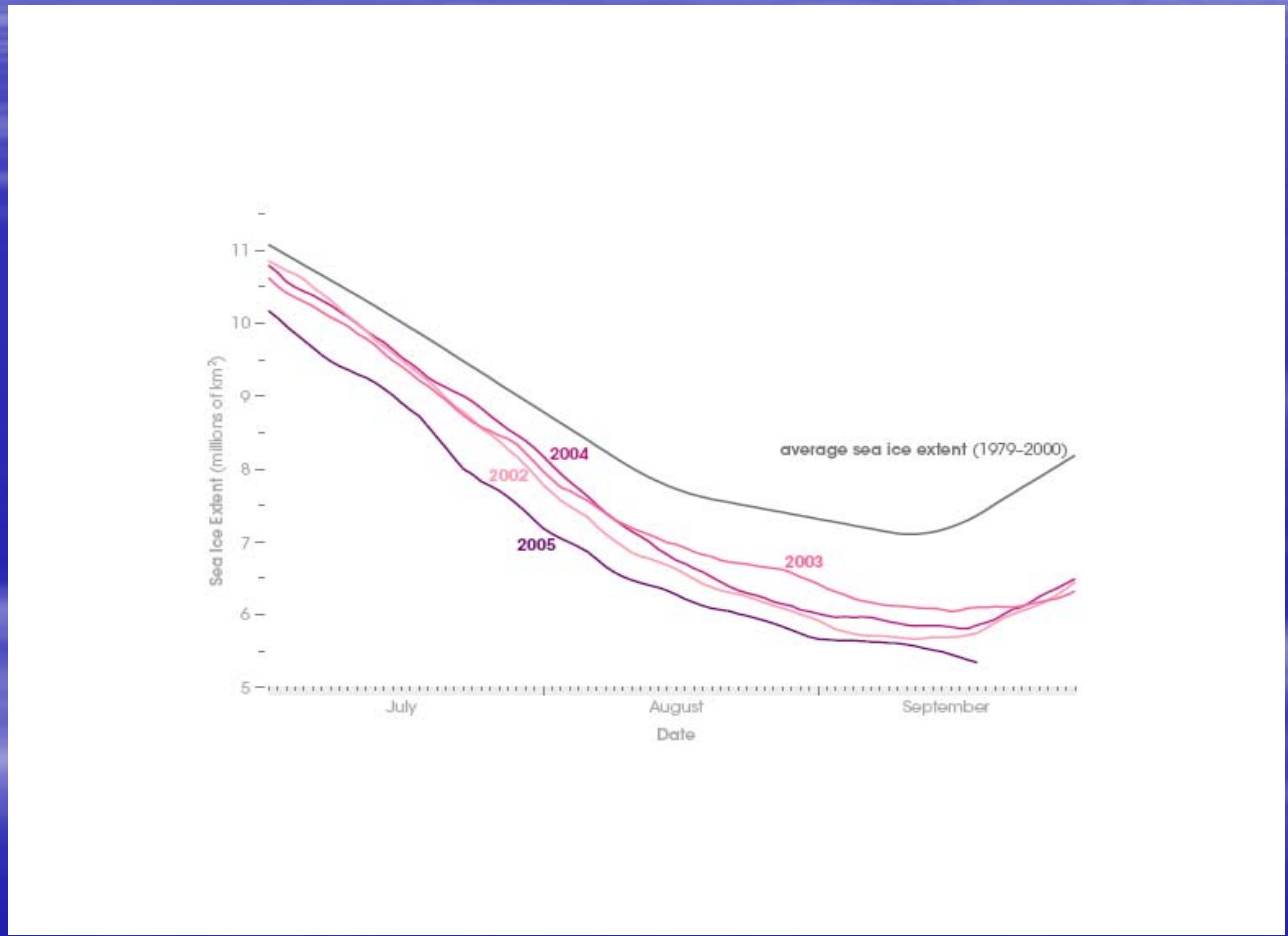
Recent Arctic Summer Sea Ice Albedo Trends and their Relationship to Sea Ice Conditions

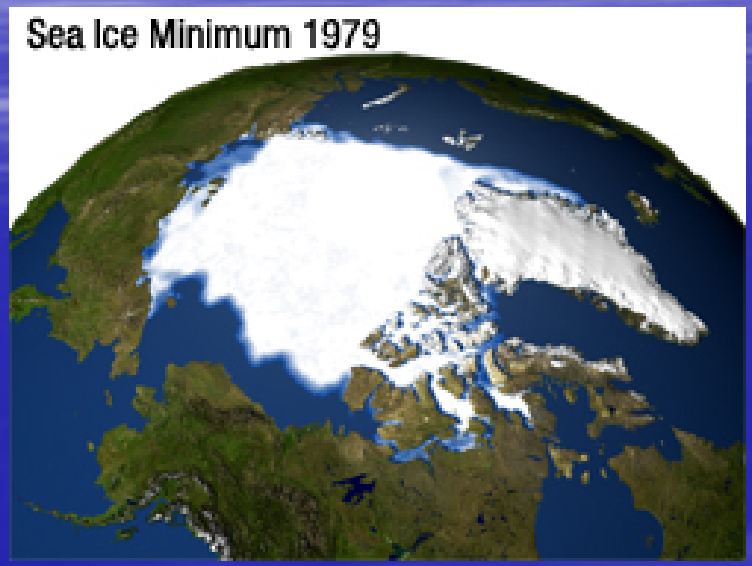
M. Tschudi, J. Maslanik,
D. Perovich

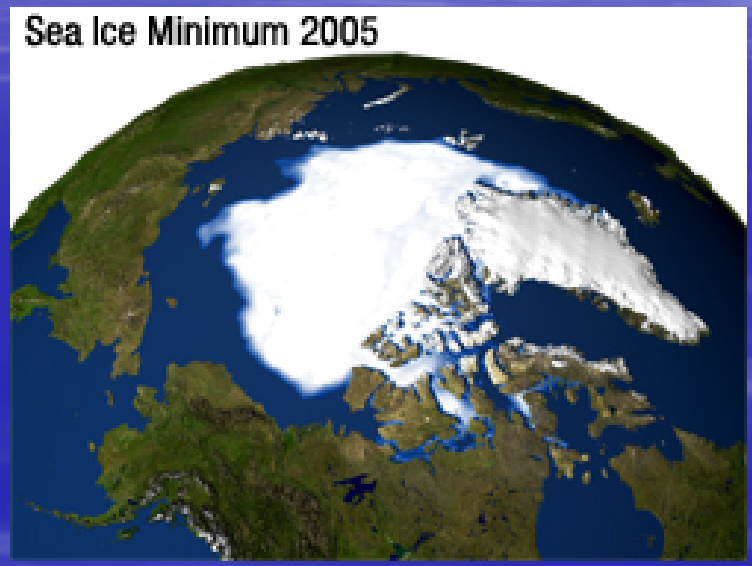
Decreasing Arctic Sea Ice Extent*



*National Snow and Ice Data Center

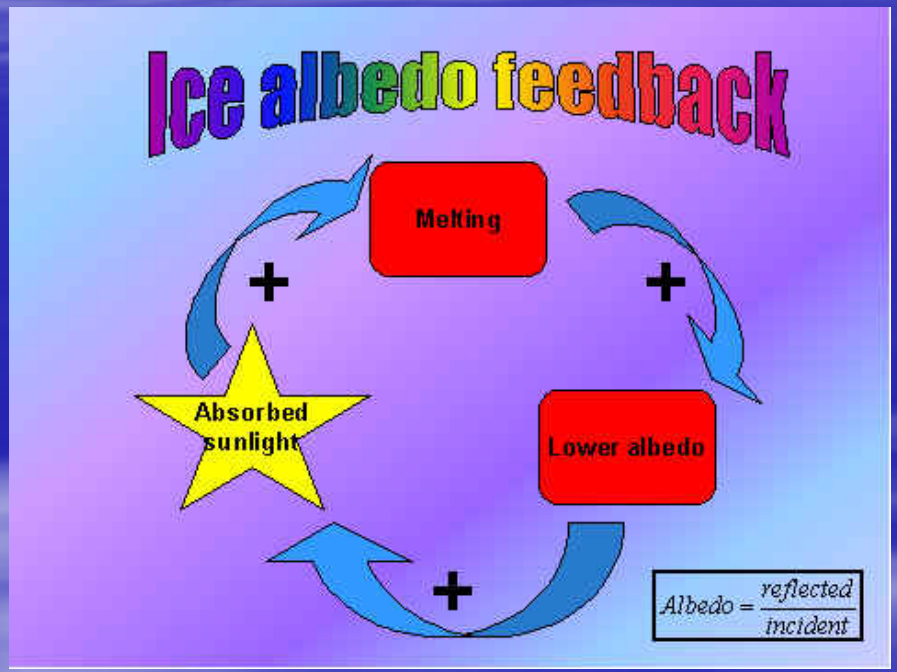
Decreasing Arctic Sea Ice Extent*





**NASA GSFC*

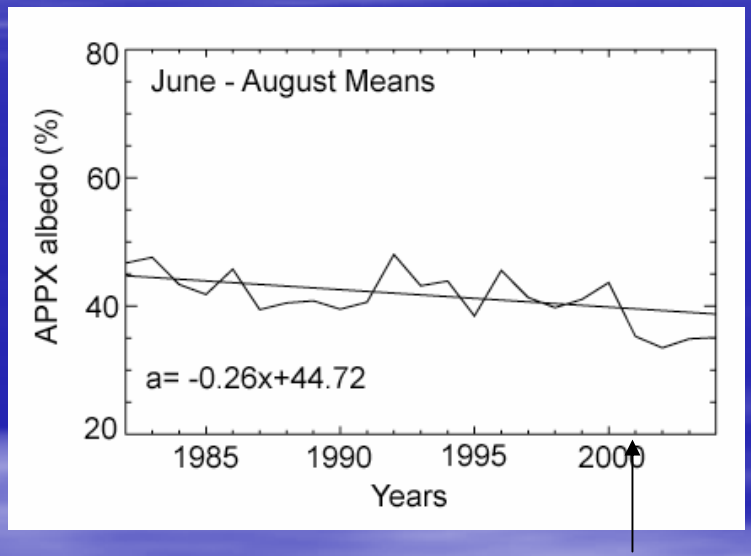
Ice-albedo feedback

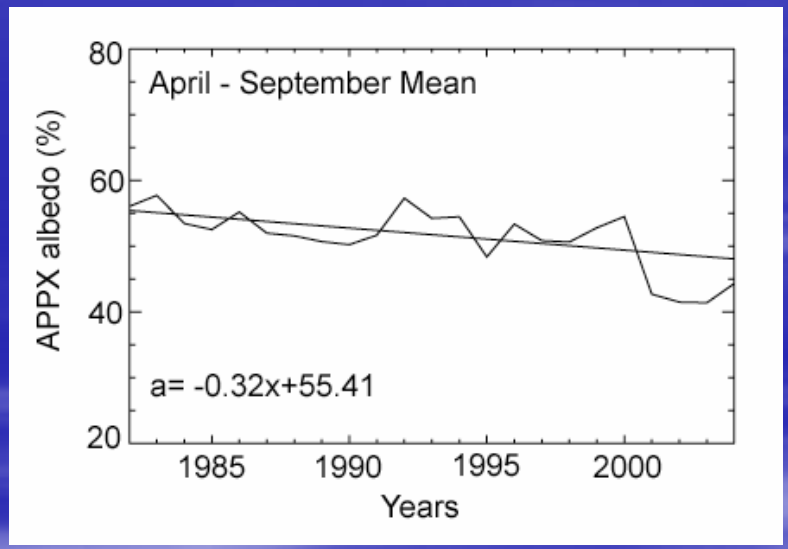


SHEBA – Beaufort Sea - 1998

Temporal Variability in Sea Ice Albedo: June-August vs. April-September Using AVHRR Polar Pathfinder Products

- Slightly greater negative trend when spring and late summer included - possibly indicating increase in melt season
- Greater decrease in most recent years (even with +10% adjustment to compensate for switch to NOAA-16 in 2001)
- Substantial interannual variability

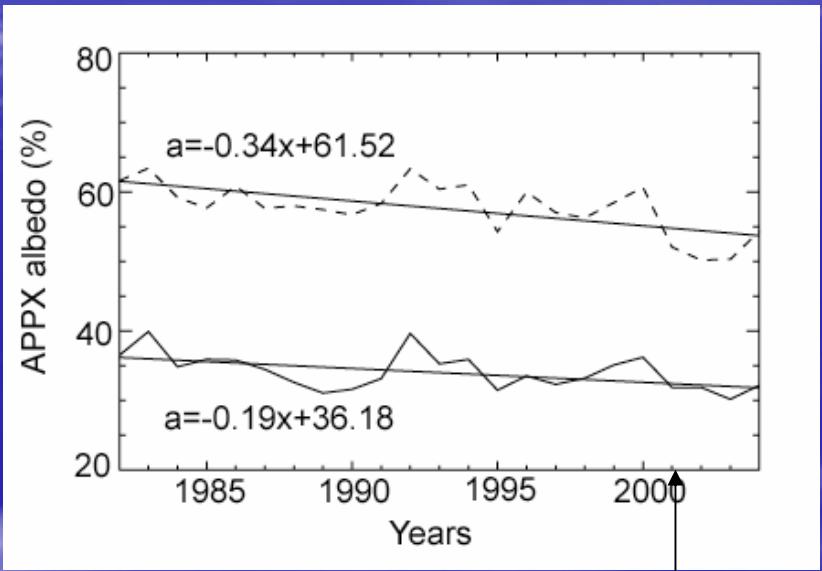




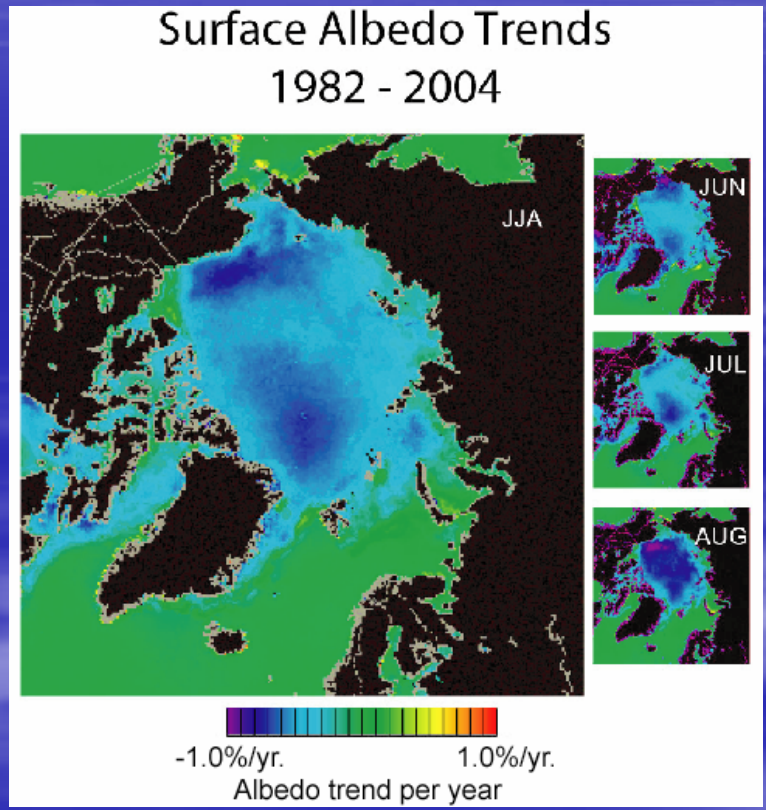
Satellite change (NOAA 16). +10% adjustment applied here.

Temporal and Spatial Variability in Sea Ice Albedo as a Function of Latitude and Time of Year

- **Negative trend greatest at higher latitudes, and in recent years**
- **Substantial interannual variability**
- **August shows extension of negative trends over entire pack**



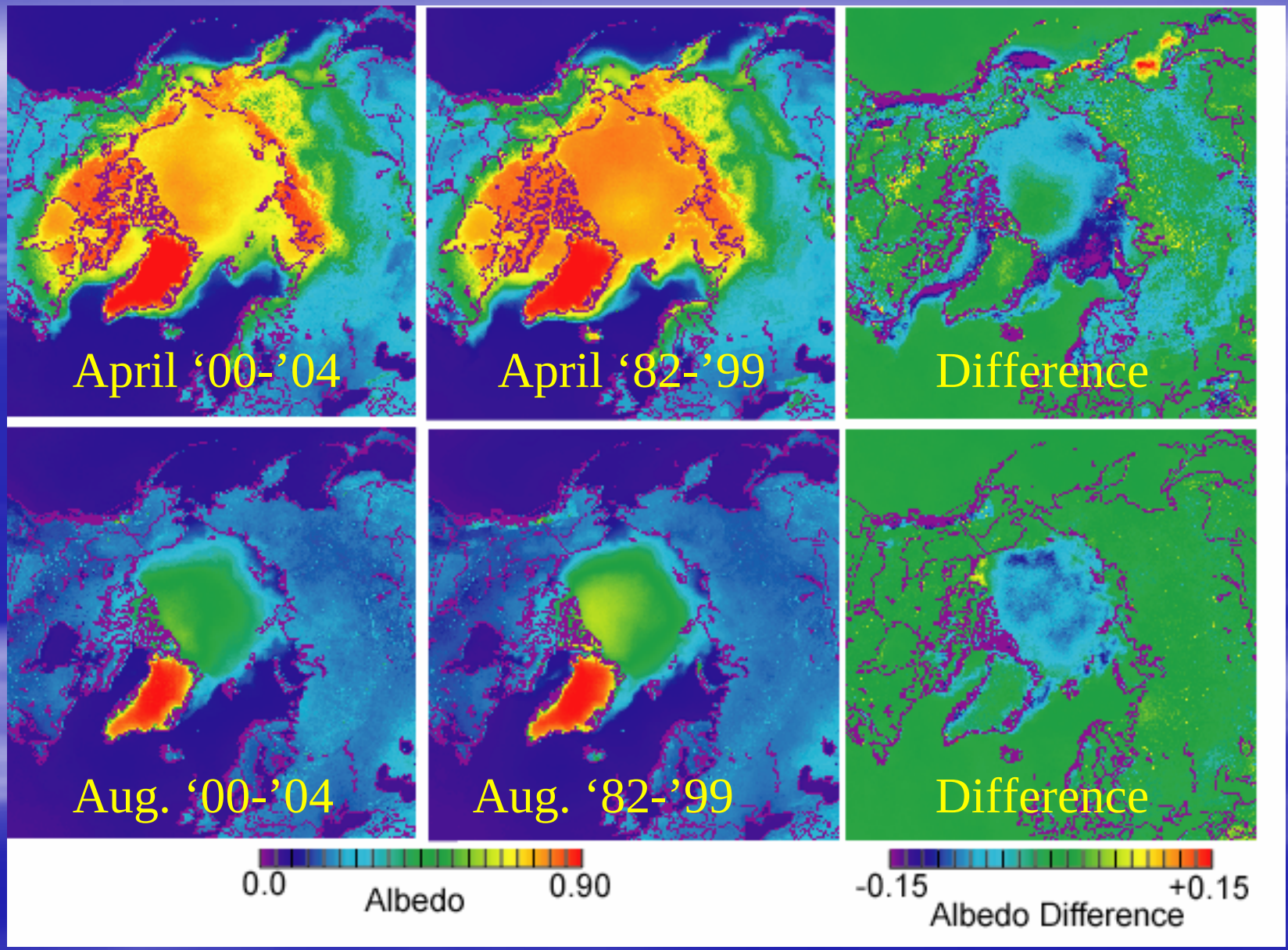
Satellite change (NOAA 16). +10% adjustment applied here.



Solid line: April-September mean albedo for 55 deg. - 72 deg. North, 15%-100% ice conc.

Dashed line: April-September mean albedo for 73 deg. - 90 deg. North, 15%-100% ice conc.

Albedo: 2000-2004 mean minus 1982-1999 mean

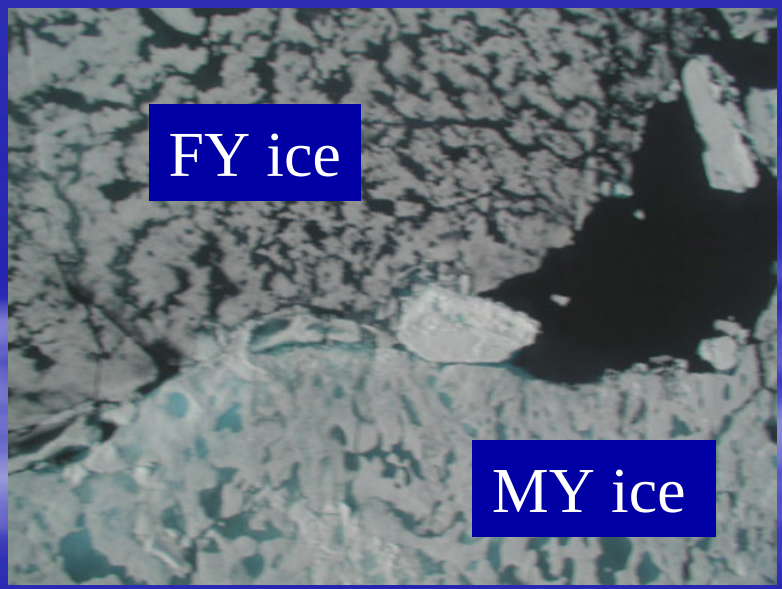


Data: AVHRR Polar Pathfinder all-sky products (APPX)

Relationships between Ice Albedo and Ice Type

Hypothesis: Loss of old ice yields net decrease in ice albedo (e.g., old ice has higher albedo than first-year ice).

Planned Approach: Analyses of airborne spectrometer data, high-resolution aerial photographs, and satellite imagery (SHEBA NTM reconnaissance data, APP and MODIS) in conjunction with ice type and ice age data.



Aerosonde photo, 17 July 2004, altitude 973m

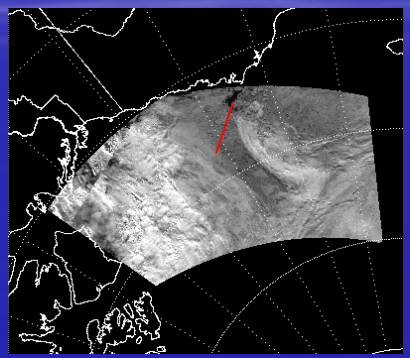
Center loc.: 73.36N, 149.9W

In this example, reflectance of FY floe is 22% less than MY floe reflectance, even though FY pond fraction is slightly less (21% vs. 24%)

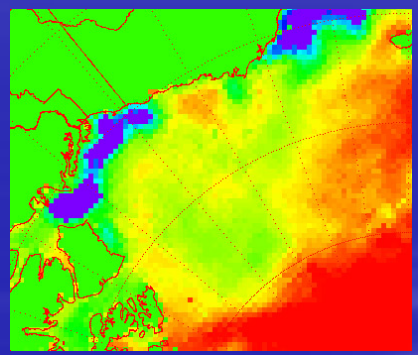
Comparison of ice parameters along UAV transect for 27 June 2004

- Some indication of higher albedo for MY ice
- SSM/I underestimates conc. in southern portion of area but good agreement further north

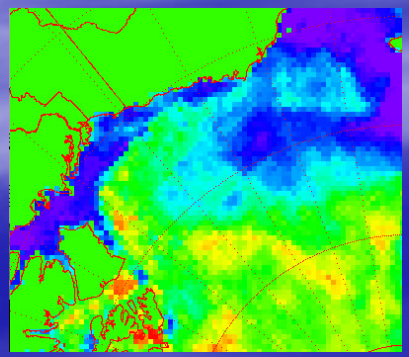
MOD09 albedo



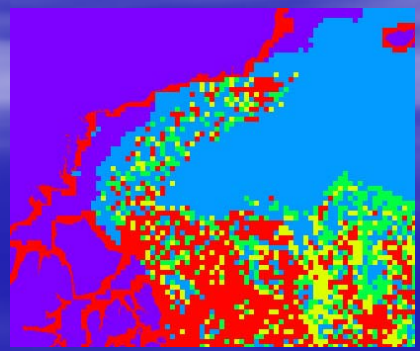
SSM/I ice conc.

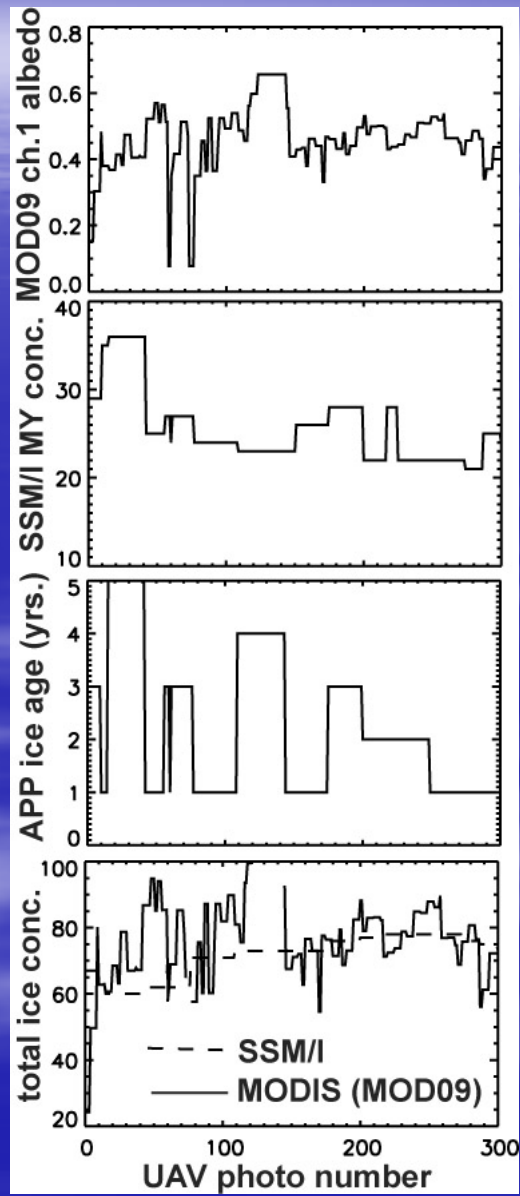


SSM/I MY conc. (1 April)



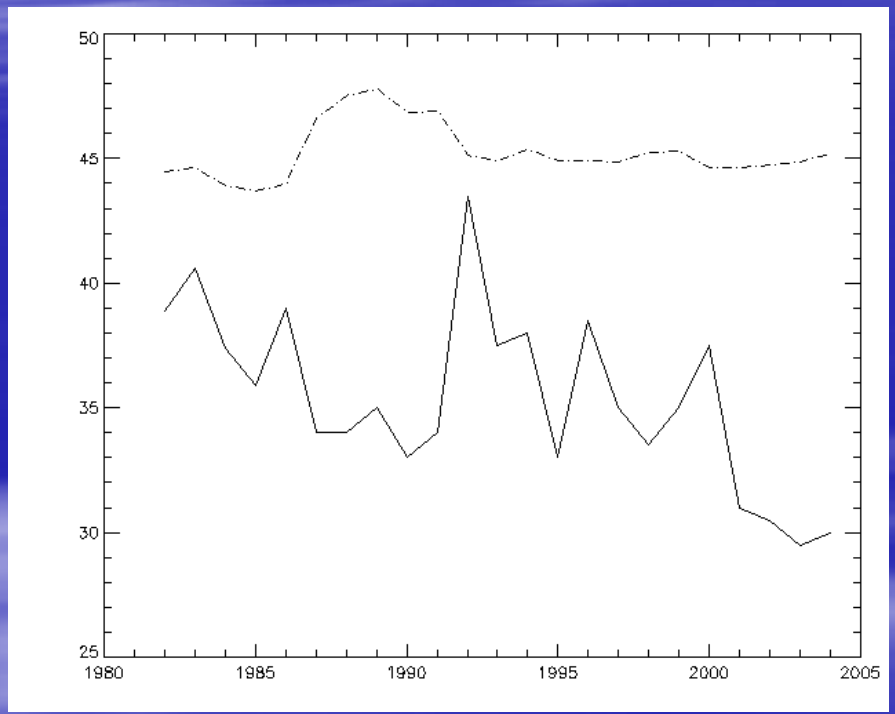
APP ice age





Summer Albedo (June-Aug) vs Ice Type

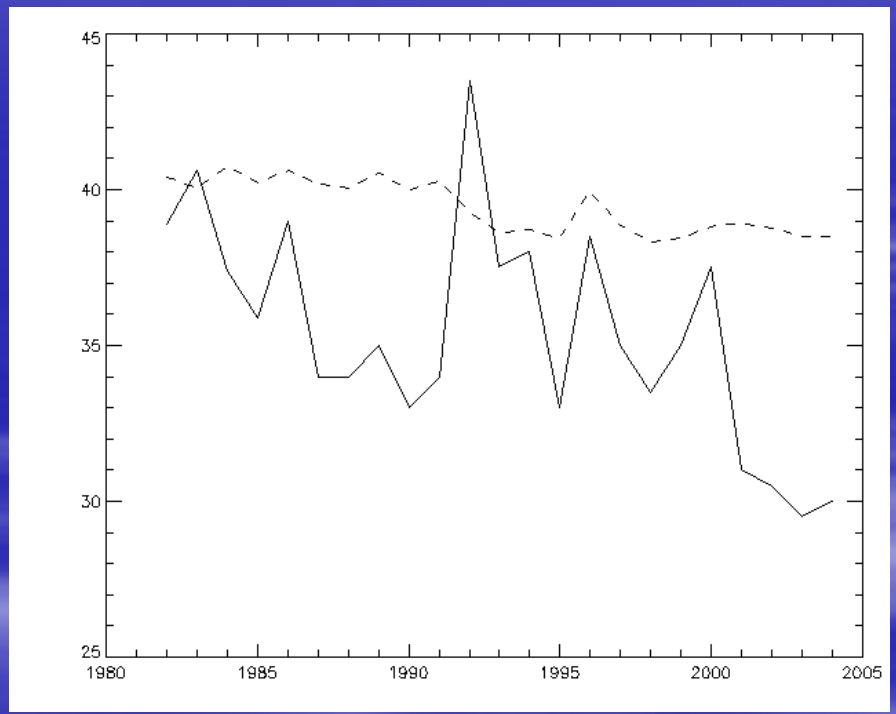
Albedo (solid) vs FYI (dashed)



correlation = -0.24

for 1986:1992 = -0.75

Albedo Solid vs MYI (dashed)



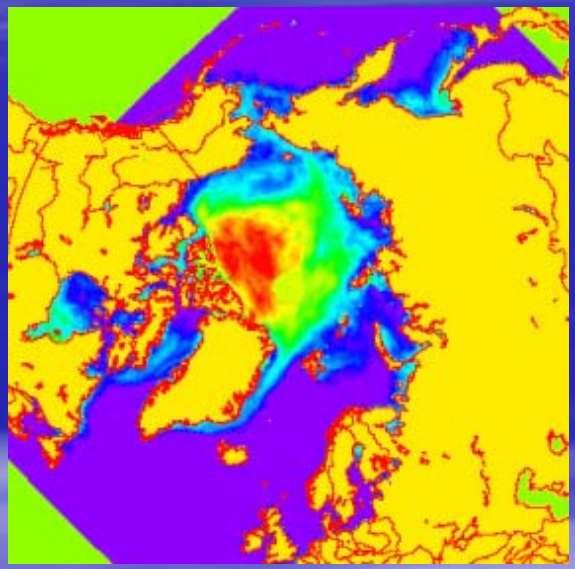
correlation = 0.39

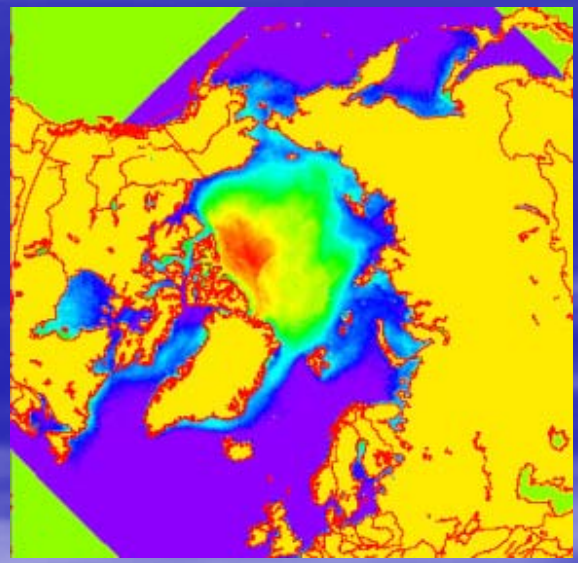
Multiyear Ice

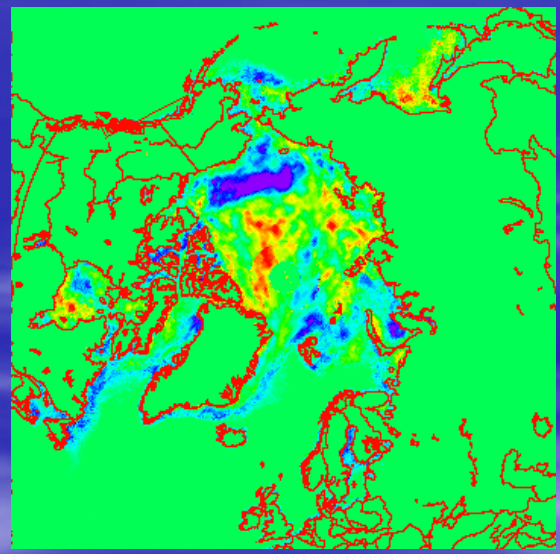
April ‘00-’04

April ‘82-’99

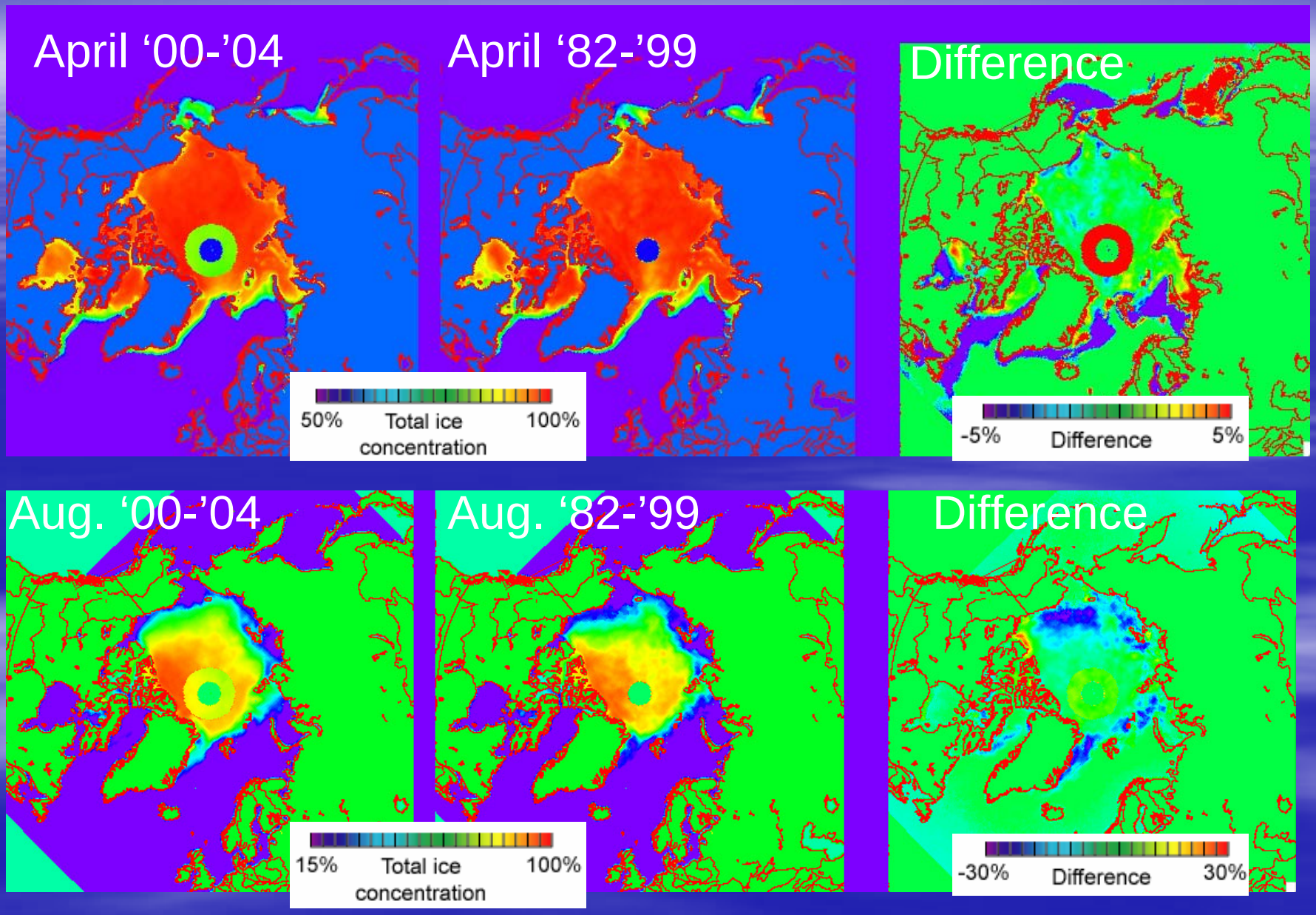
Difference



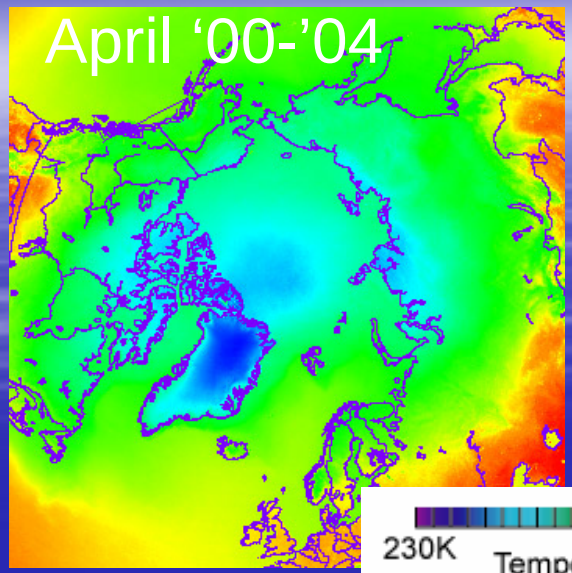


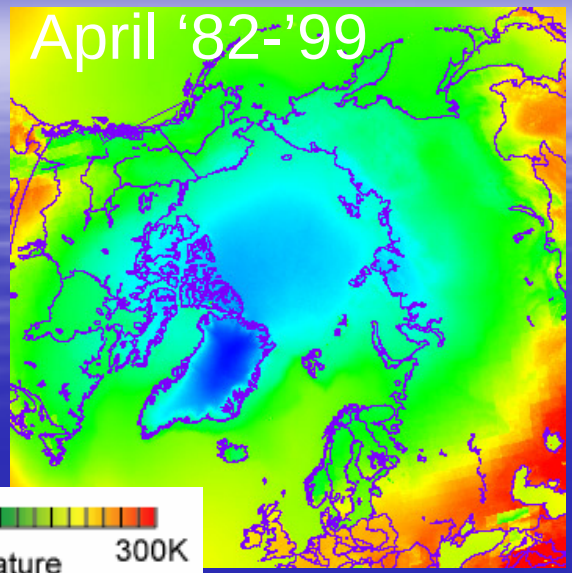


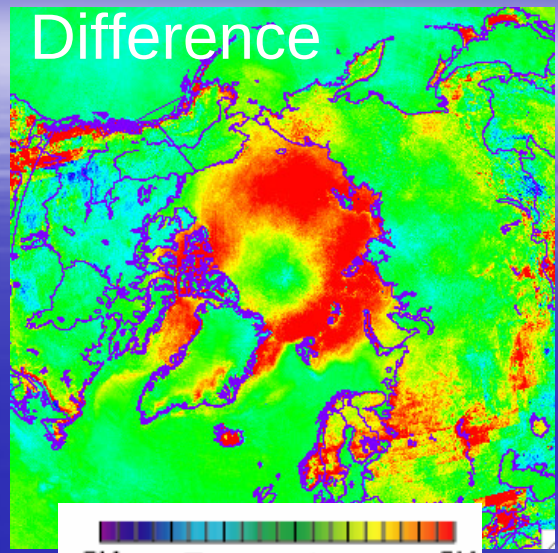
Ice Concentration: 2000-2005 mean minus 1982-1999 mean

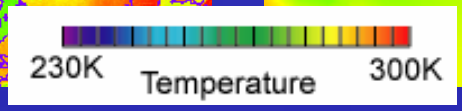


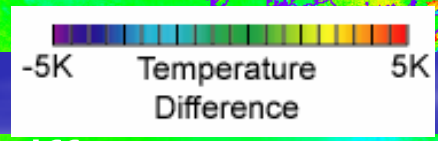
Skin Temperature: 2000-2004 mean minus 1982-1999 mean

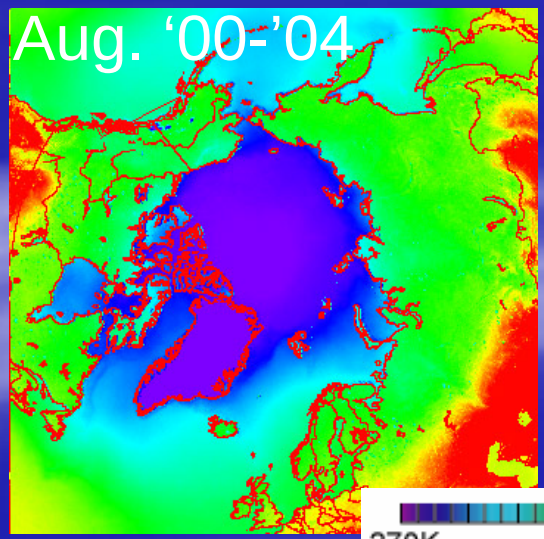


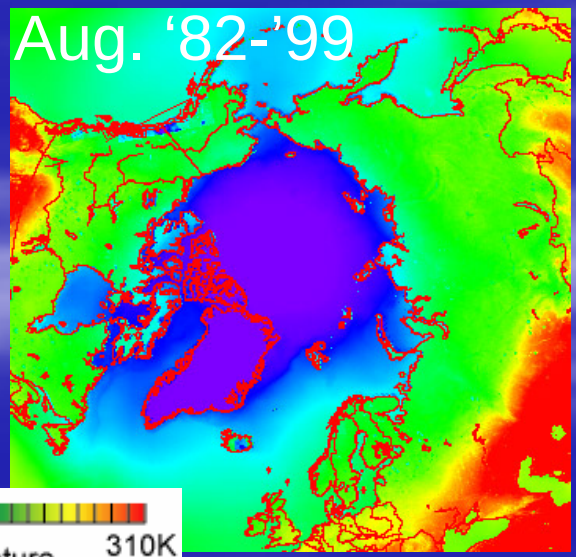


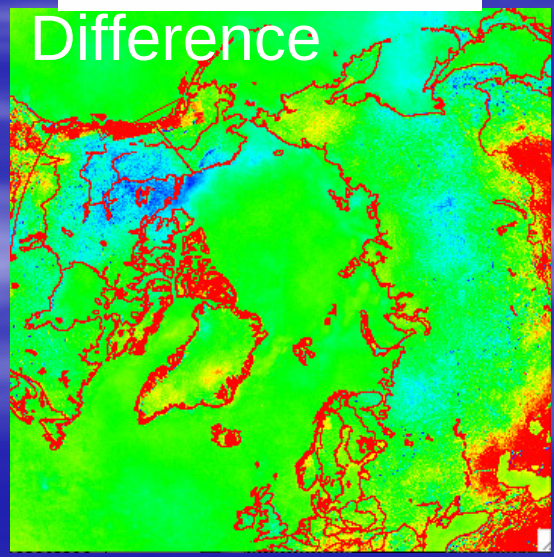


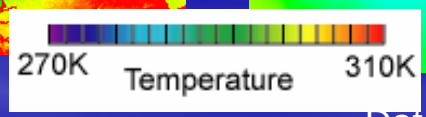






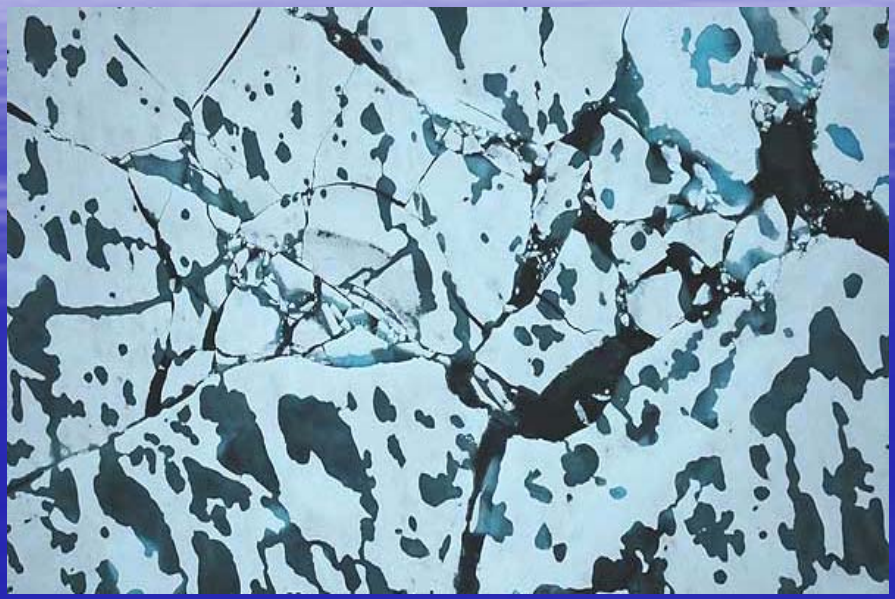


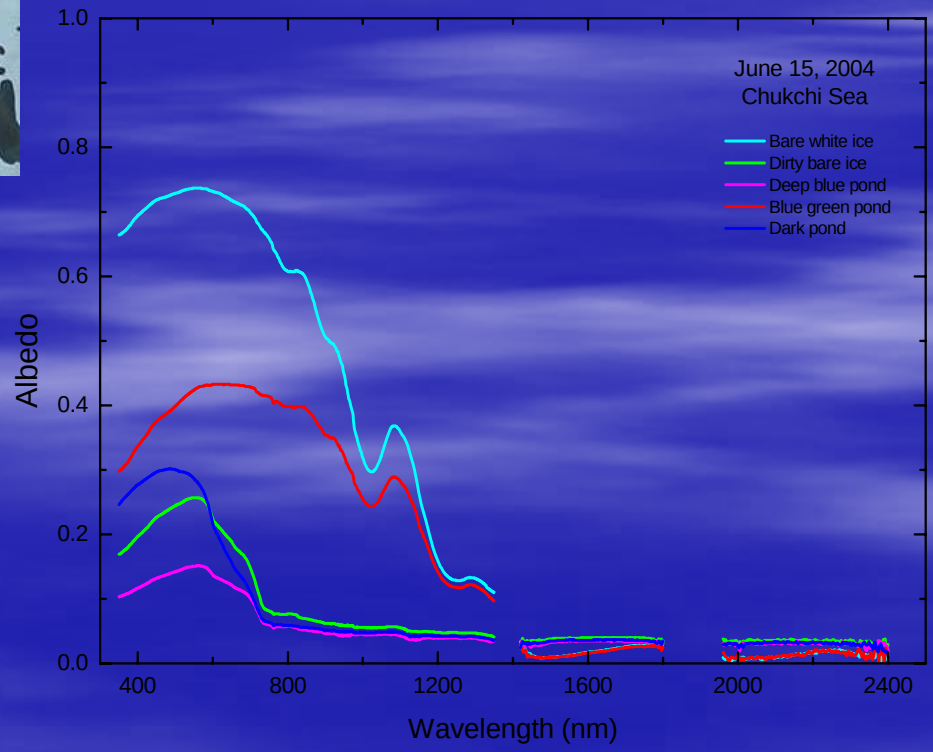




Data: AVHRR Polar Pathfinder all-sky products (APPX)

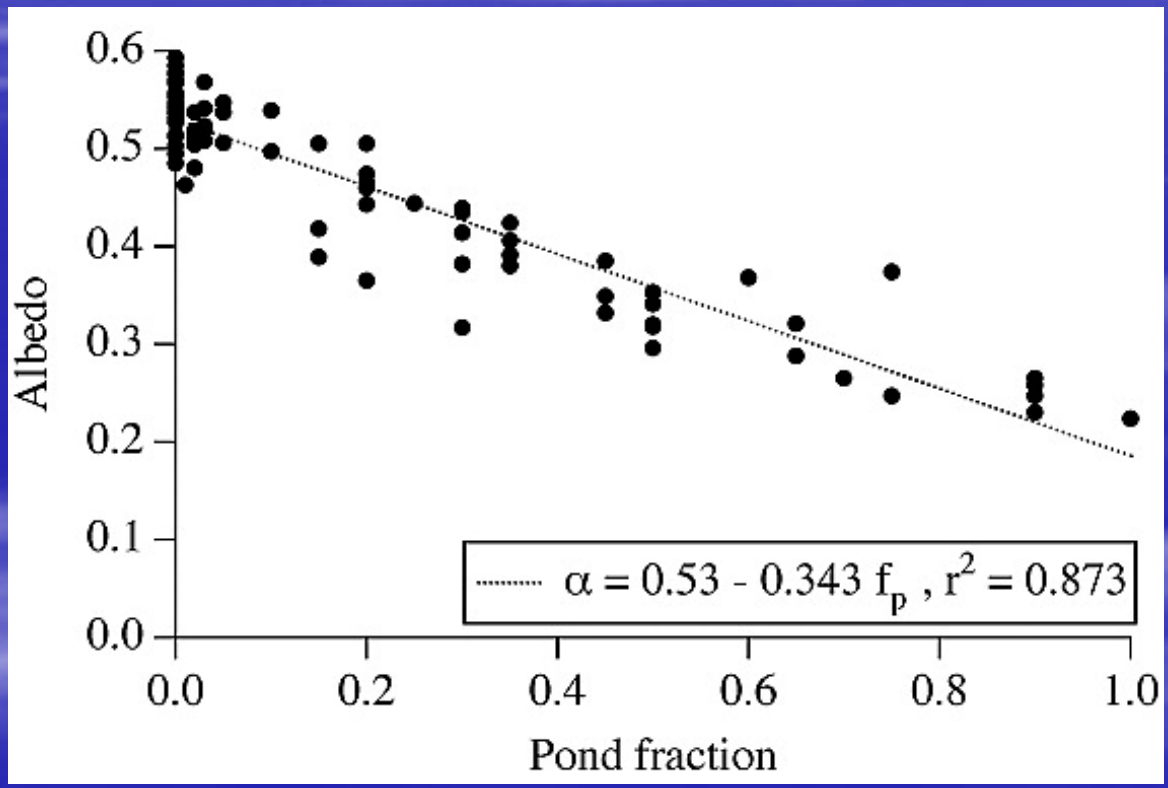
Albedo vs Melt Ponds





Albedo vs Melt Ponds

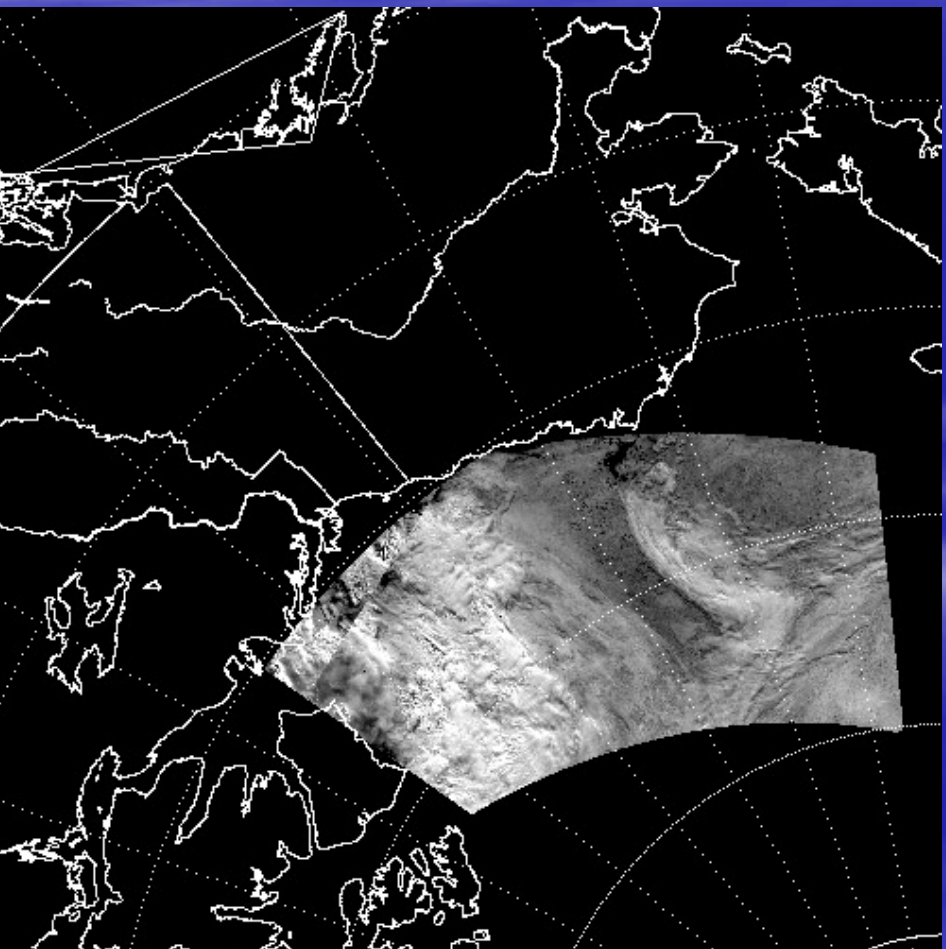
FYI near Barrow, AK, June 4 2001



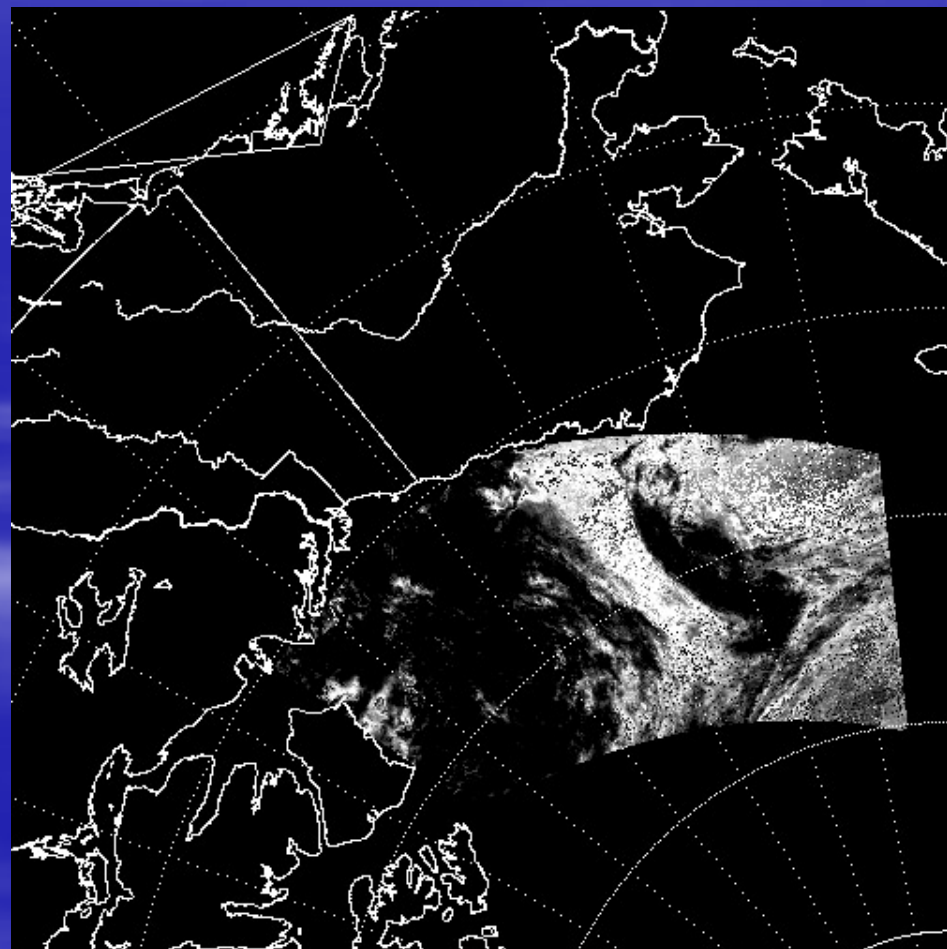
from Eicken et al [2004]

Surface reflectance and melt pond products (June 27, 2004)

MOD09 ch 1 for study area

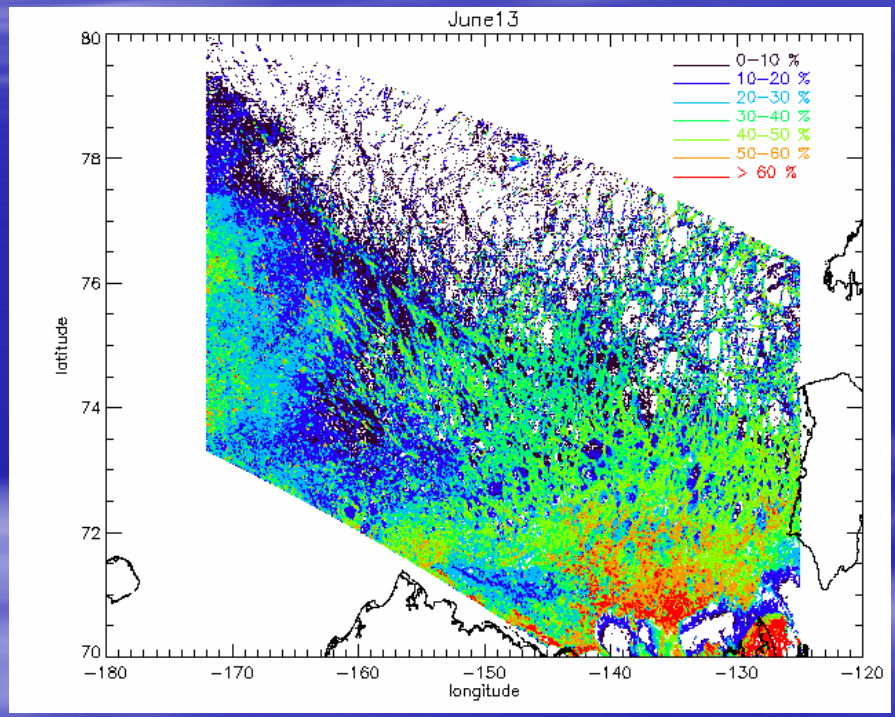


Melt pond coverage derived from MOD09

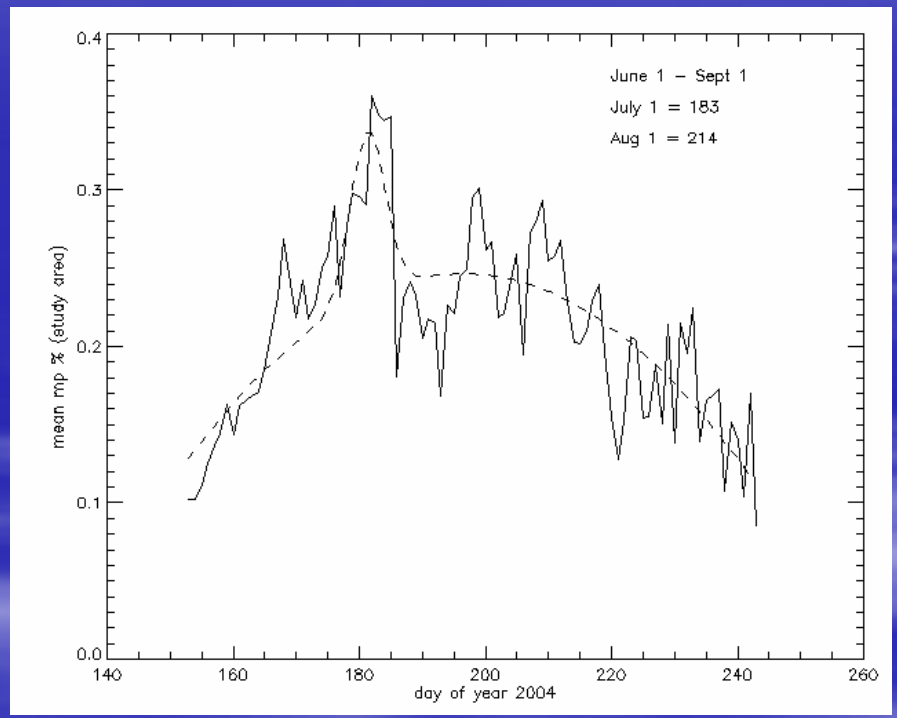


Melt pond coverage using MOD09

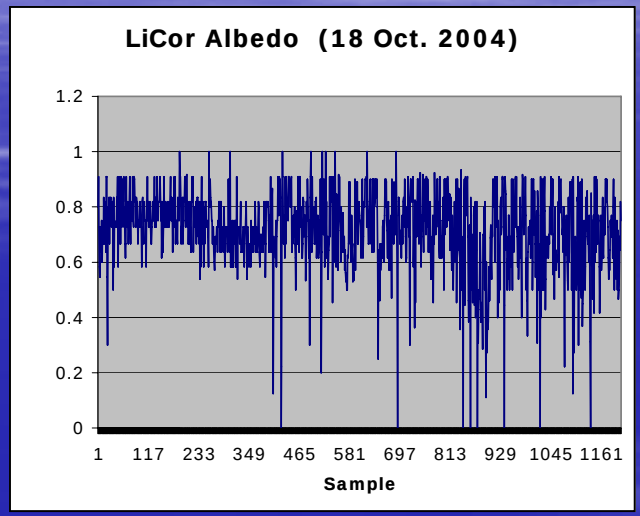
June 13, 2004



Through melt season (for area at left)



UAV Observations



Broadband (0.4 – 1.1 μm) albedo computed from up and down-looking LiCor L-200 pyranometers mounted on an Aerosonde. Mean = 0.750

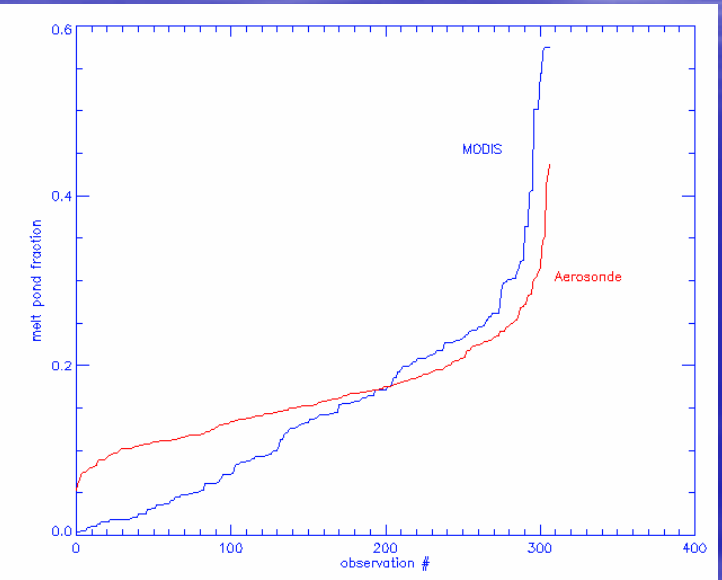
Aerosonde North America

***other instruments*: KT-11 (IST), digital camera (sfc classification)**

***next summer deployment*: spectral radiometer (sfc reflectance),**

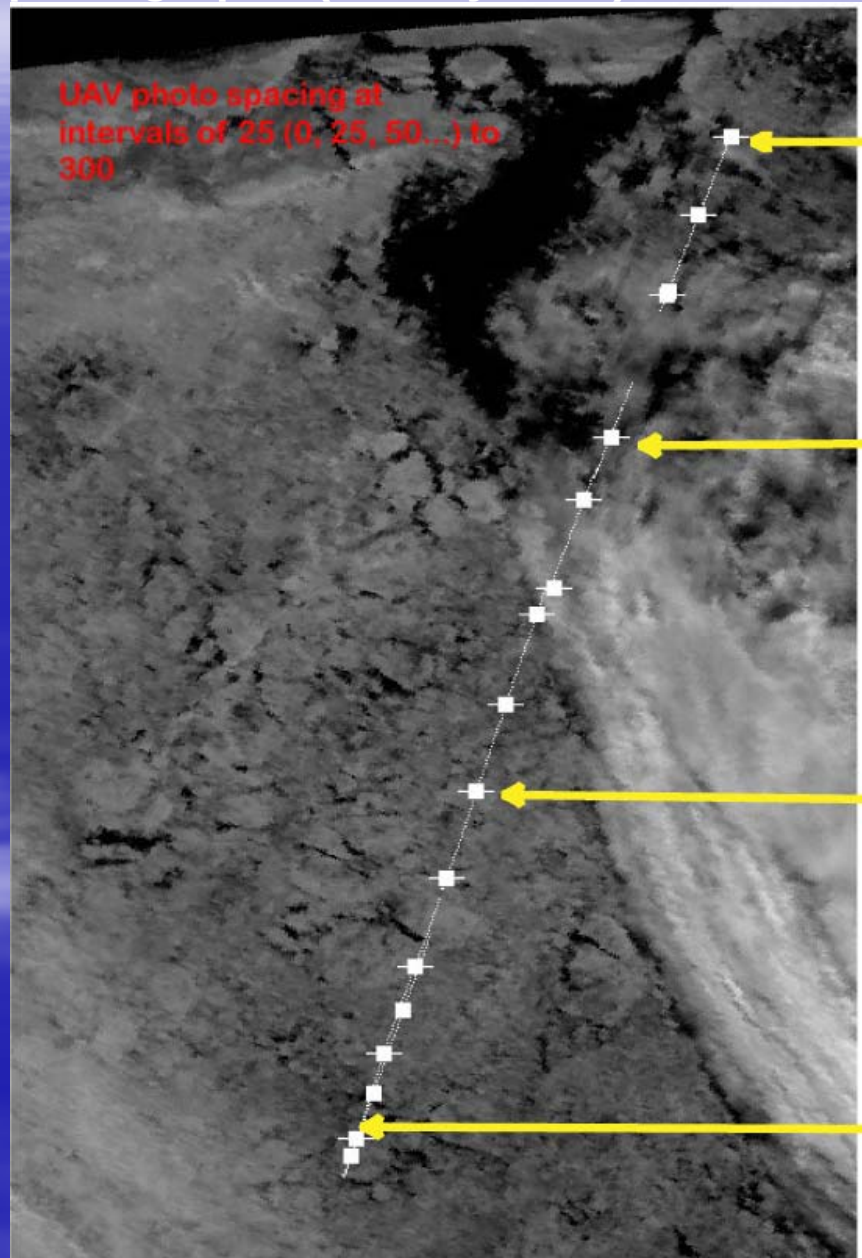
laser altimeter (roughness)

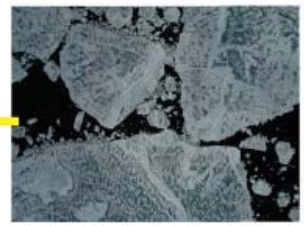
UAV/MODIS intercomparison

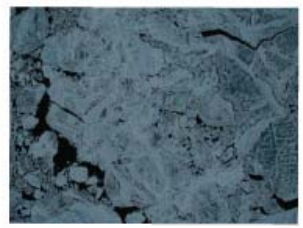


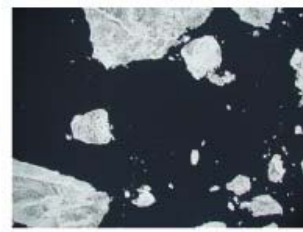
Aerosonde vs MODIS estimates of pond cover over a 10x10 km box on June 13, 2004. Observation # refers to either a MODIS pixel or digital photo from the Aerosonde.

Pathfinder-grid MOD09 channel 1 albedo and corresponding Aerosonde UAV flight track and photographs (26 July 2004)



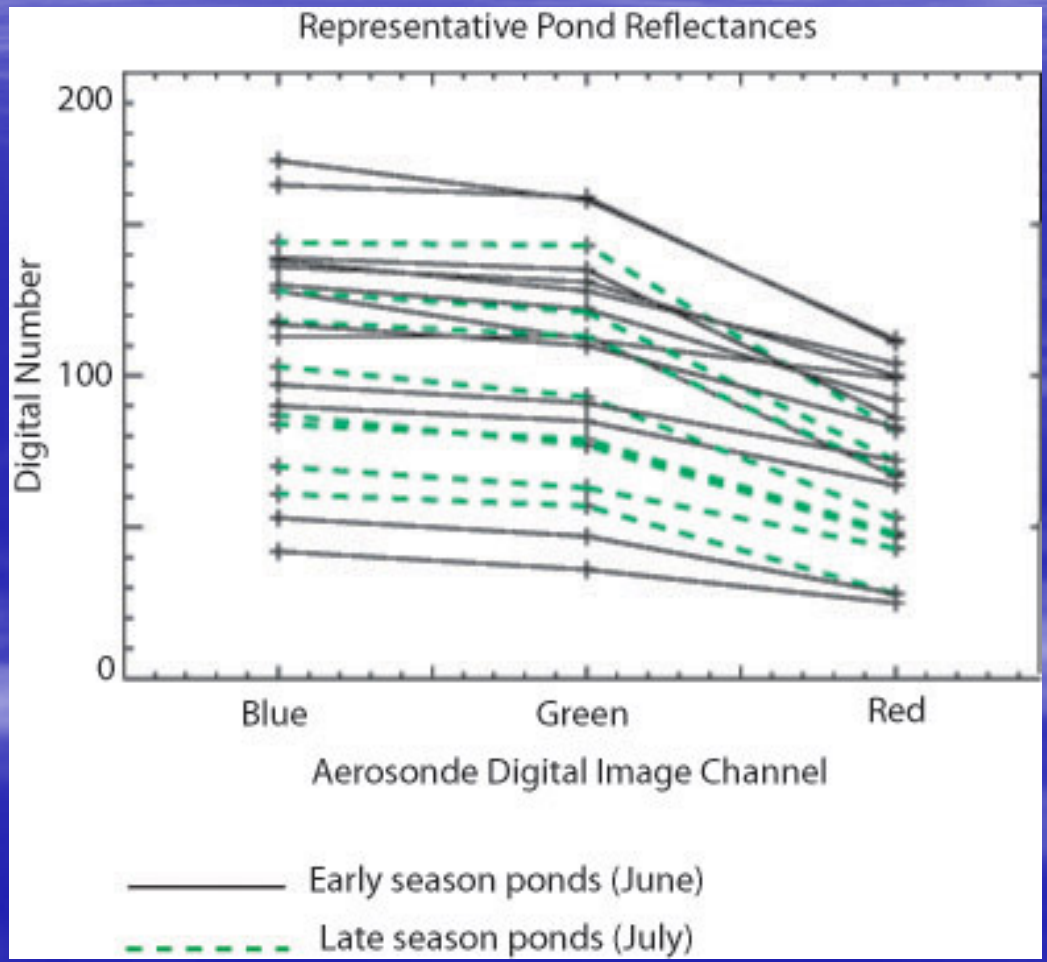




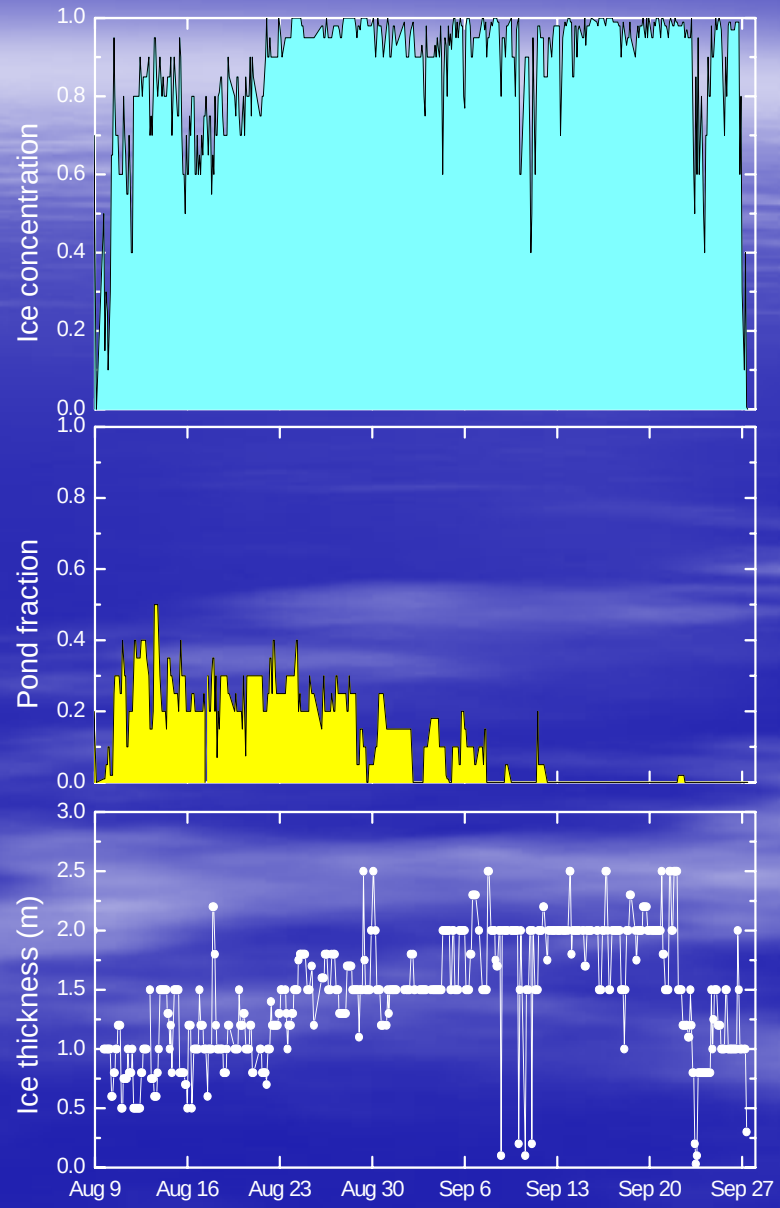


UAV melt pond reflectance

Pond reflectance obtained from analysis of Aerosonde digital camera images obtained near Barrow (2004)

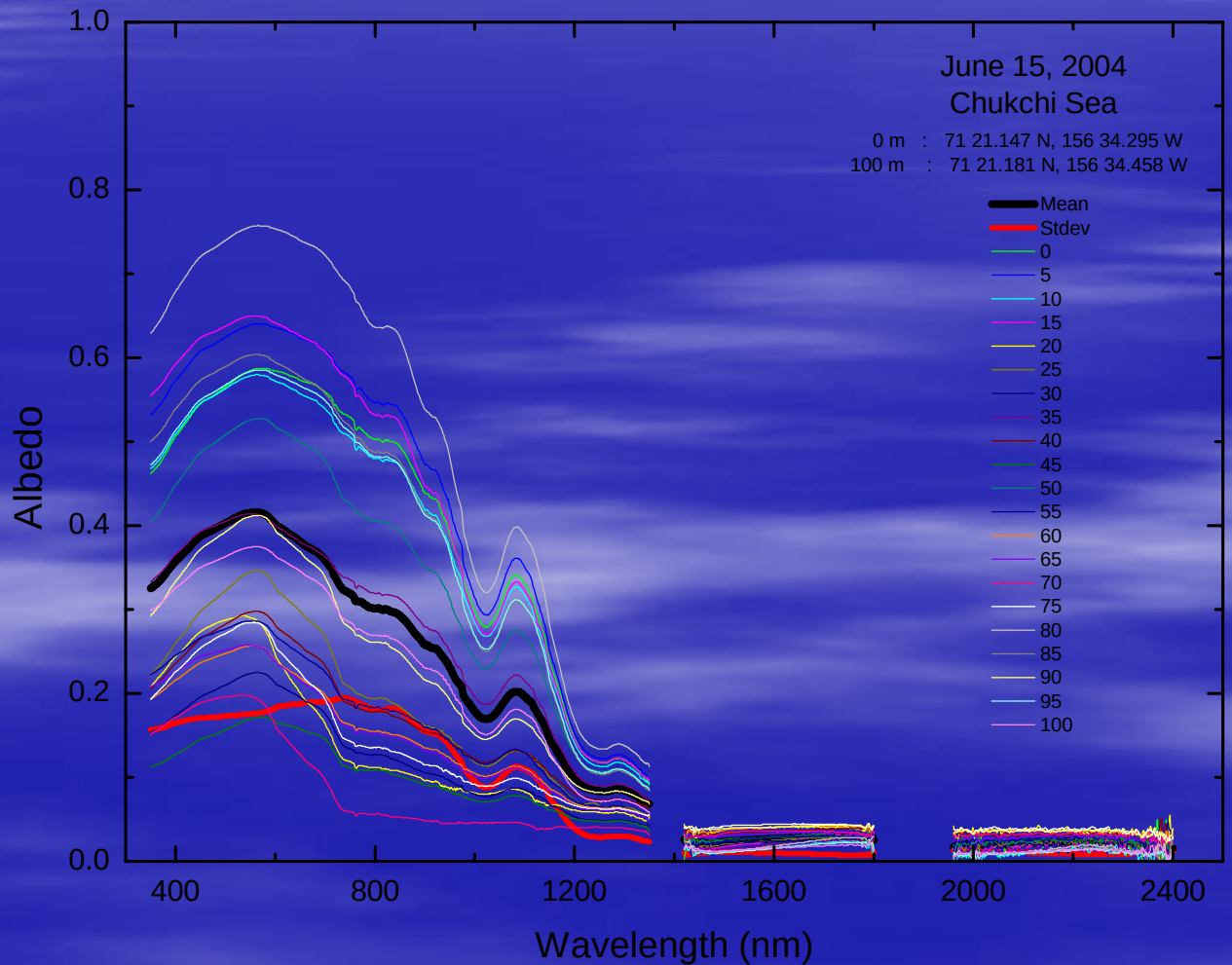


Cruising



Surface based observations provide key insights

Surface-based spectral reflectance measurements on sea ice near Barrow during June, 2004



Thanks to:

funding

Barrow deployments